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ABSTRACT

This teaching guide suggests practical ideas for encouraging science talent in preschool children. It is part of a series of similar guides developed by the RAPYHT Project (Retrieval and Acceleration of Promising Young Handicapped and Talented) for educating young gifted/talented handicapped children and gifted children with no handicaps. A list of characteristics demonstrated by children with high potential for scientific talent is followed by suggestions on how to help children see science as a process and learn to approach scientific investigations in a systematic manner. The suggested system of investigation stresses the following skills: careful observation, asking thoughtful questions, hypothesizing answers to problems, gathering information, recording findings, applying information and communicating information to others. A list of possible materials and equipment sources and a bibliography of children's science books are provided. The final section of the guide suggests activities which will help the talented child develop the basic skills in scientific investigation which were identified in the previous section. An extensive annotated list of resources is also included. (CM)

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Nurturing Academic Talent In Early Childhood

Science

Merle B. Karnes and Paula Sabatino Strong

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RAPYHT: A Model Program for Retrieval and Acceleration of Promising Young Handicapped and Talented

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Cynthia Mohrman is responsible for the art work and cover design which adds greatly to the appearance of the manual.

It is our hope that the suggestions in this manual will help teachers more effectively nurture talent among their charges and in addition, will motivate them to develop other activities for fostering talent.

Merle B. Karnes, Director, RAPYHT Project
Paula Sabatino Strong, Teacher

FOREWORD

In the Fall of 1975 the Institute for Child Behavior and Development at the University of Illinois received a grant from the Federal Bureau of Education for the Handicapped (BEH) to develop and demonstrate a model program for the "Retrieval and Acceleration of Promising Young Handicapped and Talented" (RAPYHT). Children from three to five years of age were included in the project, which has completed the last year of a three-year demonstration cycle and is entering into the first year of outreach funding.

The principle goal of this project has been to develop and demonstrate an approach for educating young gifted talented handicapped children who are enrolled in programs that also serve gifted children with no handicaps, average children with no handicaps and multi-handicapped children who are of higher but not gifted ability. Since there are relatively small numbers of gifted handicapped children in any population, the approach has been to educate them in the mainstream, but, at the same time, provide them with special programming to meet the unique needs associated with giftedness and talent.

A major outcome of this three-year demonstration project has been the completion of a set of printed materials designed to aid classroom teachers and parents who desire to identify and encourage the development of the gifts and talents of young children, including those who are handicapped. This set of materials includes guides for screening, assessing and programming for children in the areas of intellectual, academic (reading, math, science), creative, leadership, visual and performing arts (art and music), and psychomotor talent. These materials are applicable for use with young gifted/talented children as well as those who are gifted/talented with handicaps. In fact, every child has a measure of talent which may go underdeveloped unless identified and nurtured. Therefore, we are convinced that careful observation and programming in talent areas is important for all children.

We are also committed to the premise that the earlier we identify and program for talents the greater the chances that the child will fully develop his true potential. Nationwide, there have been relatively few efforts devoted to identifying and programming for young gifted/talented and even less for the gifted/talented handicapped. Hopefully, the products developed by the RAPYHT Project will create more awareness of the need to identify and program for this neglected segment of our population.

Merle B. Karnes, Ed.D.
Director of RAPYHT Project

SCIENCE TALENT IN THE PRESCHOOL YEARS

Scientific study is a very active process, which involves identifying problems and, then, solving them. It requires careful observation and first-hand exploration and experimentation. The two main goals of a preschool science program for the talented child should be: 1) to help the child maintain and use his/her natural curiosity about the world, and 2) to give the child some skills and knowledge in order to discover the answers to his/her questions. (Hodgden, 1974).

The child with scientific talent is curious about the world and spends much time examining and experimenting with whatever she/he finds. The preschool "scientist" needs little motivation, but she/he does need help in making investigations more systematic, and so, more meaningful. The system of investigation suggested in this science talent guide stresses the following skills: 1) careful observation, 2) asking thoughtful questions, 3) hypothesizing answers to problems, 4) gathering information, 5) recording findings, 6) applying information, and 7) communicating information to others.

COMMON CHARACTERISTICS OF CHILDREN WITH TALENT IN SCIENCE

The child with a high potential for scientific talent demonstrates many of the following characteristics.

1. She/he shows evidence of a questioning mind by frequently asking about the nature and function of things, e.g., "What makes a car move? Why are the birds flying all together? Where does the water in the drain go?"

2. She/he exhibits a strong desire to explore and search. The child examines objects carefully and becomes engrossed while examining things.

3. She/he takes an active interest in science activities and is self-directed during the activities. These activities may include nature studies, care of pets, simple experiments, examination or operation of machinery, and exploration with science tools (magnifying glasses, magnets, pulleys, scales, etc.).

4. She/he wants to find or verify answers firsthand. The child may disassemble toys or machinery to see how they operate or to examine the parts. She/he might repeat experiments performed by others or himself/herself to verify results.

5. She/he shows an understanding of abstract concepts, such as evaporation, basic electricity, gravity, metamorphosis, etc.

6. She/he shows advanced skill in classifying. The child notices functional similarities and differences between objects, as well as differences in color, shape, patterns, or rhythms.

7. She/her shows advanced understanding of cause/effect relationships. For example, "The plants that we picked died, because there were no roots on them"

8. She/he generalizes demonstrated principles easily. For example, the child might make a musical instrument using a stretched rubber band after she/he is shown how vibrating strings on a guitar create sound.

GENERAL METHODS TO STIMULATE TALENT IN SCIENCE

Help the child see science as a process. Learning facts is not as valuable or exiciting as learning how to approach scientific investigations in a systematic and thoughtful way. This system of investigation should basically include the following steps:

1. Observing an object or phenomena.
2. Asking questions about what is seen.
3. Hypothesizing about the meaning of what is seen.
4. Gathering information to verify or disprove hypotheses made (experimenting, classifying, using resources such as books, filmstrips, experts, etc.).
5. Recording findings (drawing pictures, dictating to a teacher, using a tape recorder, etc.).
6. Summarizing, generalizing, and applying information gathered. (This step may lead to new questions and investigations.)
7. Communicating learned information to others.

This scientific investigative process can be learned through structured activities or in an open setting. If you choose to teach structured science activities, keep the following points in mind. First, lab-type experiments are usually not effective at the preschool level. They often require too much

time to do and to see the results. They also make science seem more magical than real to children. Second, your demonstrations or activities can lead to inquiry only if the child is allowed to form his/her own hypotheses about what will happen and then test the hypotheses. Third, ask lots of questions, e.g., "What happened? Why did it happen? How do you know? Did you see anything else happen? Can you think of other reasons why that happened? How can you tell that your explanation is a correct one?" Fourth, allow the child to test or verify his/her own conclusions following a demonstration or activity. Fifth, help the child record the results of his/her investigations in order to communicate these findings to others and to use as a reference in the future. (Spodek, 1972) All structured science activities should be balanced with opportunities to freely explore science materials and use science equipment to examine the surrounding environment.

If you choose to introduce science studies in an open setting, you can help the child learn a systematic scientific approach to investigation by offering lots of stimulating materials and a special area for scientific investigations. Observe the progress the child is making in his/her discoveries, and help make these discoveries meaningful by directing the child to helpful resources, asking stimulating questions, helping him/her record findings, and encouraging the child to share information with others. It is also helpful to introduce new words to the child in order to help him/her explain and discuss any discoveries.

In order to keep interest in science activities high, keep in mind the following points:

1. Allow for investigative freedom. Don't set up tasks that the child must replicate identically. If the child gets a wild idea let him/her pursue it. For example, if the child wants to see if pulleys work under water, allow or help him/her to find out.

2. Reinforce scientific creativity by positive recognition. Tell the child when she/her has an unusual or exciting idea. Even if a child's idea seems worthless to you, allow him/her to carry it out. Never say, "No, that won't work." Let the child find out.

3. Recognize the child's ability as a problem solver. Realize that she/he can make hypotheses, design experiments, collect data, make inferences, generalize and draw conclusions, no matter how simple his/her ideas may seem.

4. Help the child see that there are several ways of looking at a problem and finding solutions to it. Have several children work on problems together, or have them discuss their findings in a group after they have worked on a science problem.

5. Encourage children with high science interest to work together to stimulate each other.

6. Attempt to keep the curiosity of the child alive. Provide lots of materials, go on field trips, ask questions about what the child is doing, and be receptive to the child's questions.

7. Encourage inquiry. Help the child find the answers to his/her questions by guiding him/her towards stimulating activities or resources.

8. Allow the child to work alone if she/he desires. She/he may be engrossed in an investigation and resent interference by others.

9. Don't rush the child through a project. Allow time for discovery and learning.

10. Give the child as many opportunities to participate and experiment as possible. Keep explanations short. Allow the child to play with materials, examine and try equipment, and create his/her own experiments.

11. Give the child choices. Introduce science materials and ideas. If there is interest, help the child extend it. If there is no interest, drop it. Be sensitive to the child's interests.

12. Reinforce a positive attitude. If the child feels that she/he has failed, show how she/he has succeeded. For example, if the child plants a seed, and it won't grow, help him/her find out why not (too much water, poor soil, sterilized seeds, etc.). Then encourage him/her to plant another seed using this new knowledge.

13. Be creative yourself. Vary your methods of introducing a topic. Sometimes take a field trip, other times show slides or read a book to the child or introduce him/her to new science materials.

Equipment

In order to encourage involvement in science activities, especially during non-directed times of the day, set up an area in the classroom exclusively for science exploration. This area should be fairly isolated from other activity areas. It should include a cabinet or shelves for storing equipment and ample counter and/or table space. You might also want to provide a place for children to display their own projects. Or you may want to use a display area to present new materials. Teacher displays should allow for or lead to manipulative activity by children or they have no meaning. For example, if you set up a neat arrangement of rocks, but don't allow children to handle them, they will quickly lose interest. Displays should be changed regularly to sustain interest.

Equipment is an important part of the science area. It need not be expensive or elaborate. You can pick up most of it for free or at a very low cost. Whatever equipment you choose, consider two things: the motor abilities of the child and the safety factor of the equipment. The following is a list of possible material and equipment sources.

1. Materials found in nature (rocks, soil, leaves, seeds, shells, nests, webs, clouds, streams, bark).

2. Materials found in a home (pans, jars, other containers, spoons, strainers, salt, sugar, food coloring, wood and metal scraps, mirrors, nails, bolts, flowerpots, hooks, hinges, pieces of cloth).

3. School materials (ball, paints, globes, measuring instruments, clay, scissors, musical instruments, colored paper, paste, string, chalk, blocks, straws).

4. Materials in the surrounding neighborhood (machines for road repair, construction sites, factories, farms, wooded areas, parks).

5. Materials from local sources (discarded clocks from a jewelry store, insulated wire from a radio repair shop, wood scraps and sawdust from a lumber yard, plants and soil from a nursery, discarded automobile and airplane parts).

Other materials you may want to provide may include gardening tools and equipment, construction tools, pulleys, batteries, electrical switches, flashlight, balancing scales, thermometers, locks and keys, lenses, prisms, funnels, magnets, tuning forks, and classroom pets.

Bibliography of Children's Science Books

This bibliography lists a few books for preschoolers which can serve as simple references, or which can be used to explain various scientific concepts.

1. Bason, L. Spiders. National Geographic Scoeity, 1974.

This book contains many fascinating color photographs of spiders and their webs. The text is easy enought for a preschooler to understand. Although the text would not hold a young child's attention from cover to cover, this would make an excellent reference book on spiders.

2. Cartwright, S. Sunlight. New York: Coward, McCann and Geoghegan, Inc., 1974.

This book helps the child become aware of the sun and its powers. Simple questions, appealing illustrations, and suggested activities hold the preschool child's interest and invite the child to actively explore sunlight.

3. Cartwright, S. Wind is to feel. New York: Coward, McCann and Geoghegan, Inc., 1974.

Geared towards the preschool level, this book presents properties of the wind through suggested observations and activities. The bright and attractive illustrations and simple text encourage the young child to investigate the wind and its effects.

4. Cole, J. and Wexler, J. A chick hatches. New York: William Morrow and Company, 1976.

Although the text is somewhat advanced, the descriptive photographs make this an excellent resource on embryo development. A non-reader can obtain much information and get a sense of the developmental stages by looking at the pictures.

5. Conklin, G. When insects are babies. New York: Holiday House, 1969.

This book offers very simple explanations of the life stages of sixteen kinds of insects. The illustrations are very clear and the text is geared to the preschool level. This would serve as an excellent fact book about insect life cycles.

6. Ipcar, D. The wonderful egg. Garden City, New York: Doubleday and Company, Inc., 1958.

For the dinosaur lower, the simple text and clear illustrations of this book offer a clear description of dinosaurs and their habitats. The introduction of the bird, a new type of animal, at the end of this book, suggests to the young child the idea of evolving life forms.

7. McClung, R. M. Animals that build their homes. National Geographic Society, 1976.

This book is a fascinating introduction to animal homes in the wild. The large and colorful photographic illustrations hold the interests of the young child and help to clarify the simple text. Animals included are beavers, prairie dogs, badgers, crayfish, several kinds of birds, insects and fish.

8. McClung, R. M. How animals hide. National Geographic Society, 1973.

The large and excellent photographs in this book show the young child how animals are camouflaged in their natural habitats. The simple text offers questions which encourage the child to find the pictured animals and think about how camouflage helps animals survive.

9. National Geographic Society, Creepy crawly things: Reptiles and amphibians. National Geographic Society, 1974.

The large color photographs and easy text make this an excellent reference book on reptiles and amphibians.

10. Podendorf, I. Color. Chicago, Illinois: Children's Press, 1971.

In this book, the child is introduced to color, shades of color, and how to combine basic colors to create new colors. The very simple text offers many questions and suggested activities to introduce the child to principles of color.

11. Selsam, M. E. A first look at birds. New York: Walker and Company, 1973.

This book describes the differences between various kinds of birds. The text is simple and uses questions to involve the child in observing pictured birds.

12. Selsan, M. E. Is this a baby dinosaur? New York: Harper and Row Publisher, 1971.

The child will enjoy identifying the photographs of natural objects in this book. Each object is shown partially on one page with questions that invite the child to identify the object, which is shown in full on the following page.

13. Shapp, M. and Shapp, C. Let's find out about water. New York: Franklin Watts, Inc., 1975.

This book explains to the young child that all living things need water and how humans also use water for recreation and mechanical needs. There is a simple explanation of where water comes from, how it is stored and obtained for city use and some of the characteristics of water. The text is very simple and the illustrations, which are very bright and attractive, clarify the text well.

14. Shapp, M. and Shapp, C. Let's find out what's light and what's heavy. New York: Franklin Watts, Inc., 1975.

The brightly colored and humorous illustrations make the simple text of this book attractive to preschoolers. The book introduce the principle of weight by offering comparisons between light and heavy objects. The Shapps show how the terms "light" and "heavy" are relative to the person lifting things and suggest using a scale to determine true weights.

15. Showers. P. What happens to a hamburger. New York: Thomas Y. Crowell Company, 1970.

Although this book may be lengthy for preschoolers, the simple illustrations and humorous text make an enjoyable explanation of human digestion. The author has included some very simple activities to make the process clearer to young children.

GOAL AREAS AND ACTIVITIES

This section suggests activities which will help the talented child develop basic skills in scientific investigation.

A. To increase careful observations

1. Ask several children to lie down outside and look at the sky. Ask lots of questions, e.g., "What do you see? Are the clouds and the sky the same color? What colors are they? What are the clouds doing? Are the clouds the same or different? How are they the same? How are they different? Where is the sun? Do you see a bear, monster, etc., in the clouds?" Encourage the children to comment and ask questions about what they see. Encourage them to answer each other's questions.

2. Ask the child to collect two or three rocks. Ask him/her to describe the rocks. You might encourage him/her by asking questions, e.g., "How are your rocks different/the same? Can you scratch the rocks? With what? What happens when you wash them? Do they look the same wet and dry? Can you draw with any of them on a sidewalk? What is inside the rocks? (break them) Can you put the rocks back together after you break them?" Encourage the child to pose questions to himself/herself and, then, try to answer or find the answers to the questions.

3. Empty the trash basket onto the floor. Allow the child to look through the trash and describe what she/he finds. Some questions you might ask

are, e.g., "What is in the trash? Is there anything we could use again? What for? What are these things made from? What does the garbage collector do with the trash?" Provide resources so the child can discover answers to these and his/her own questions. Resources include simple, well-illustrated fact books, field trips, a visiting trash collector. Explore trash in other areas--the school kitchen, the bathroom, offices, a park. Visit a restaurant, gas station, department stores, etc. What kinds of trash do each of these places produce? This lesson can be a simple introduction to the study of ecology.

4. Take the child on a walk. Have the child collect a jarful of soil to take back to the classroom. Have him/her search through the soil to see what she/he can find.

5. Give the child a bag with an object in it. Tell the child to touch the object in his/her bag and describe how it feels. Encourage him/her by asking questions, e.g., "Does it feel bumpy, round, smooth, etc.? Is is heavy? Is it hard or soft?" Suggest that the child use other senses besides vision to explore the objects, e.g., "Does it smell? Does it make any sounds? What does it taste like?" Encourage the child to think of other ways to examine and/or describe the object.

6. Give the child a container of water, an eye dropper, a sheet of wax paper and a magnifying lens. Let him/her play freely with the materials. She/he will soon learn to manipulate the eye dropper, examine water drops on the paper with the lens, roll the drops on the wax paper, etc.

Then ask the child what she/he did, what happened and what she/he saw when looking through the lens at the water drop.

7. Ask the child to close his/her eyes and identify any sounds she/he hears. Next, tell the child to listen with one ear pressed to a table and identify the same sounds. "Do the noises sound different? Are they louder/softer? Are there more sounds?" Tell the child to cup his/her hands behind his/her ear while you recite a rhyme. Then tell the child to cover his/her ears while you recite the same rhyme. Ask the child how the sounds differ.

8. Obtain a windup clock. Take off the back and allow the child to observe the working mechanisms.

B. To increase questioning skills

1. Put a scientific tool in a "secret box." Have a puppet show the child the box and tell the child that she/he may peek in the box after she/he asks a question about the secret object, e.g., "Is it small? Can I see through it? Is it heavy?" The object may be a magnet, a magnifying glass, a pulley, a microscope, a measuring instrument, etc. After the child has asked one question, have the puppet take the tool out of the box and allow the child to play with the tool after she/he asks a questions about it. Keep reference books on hand for the puppet to look up answers to any questions that you might not be able to answer.

2. Repeat the above activity with objects from nature, machinery, animals, etc.

3. Demonstrate questioning skills by asking "good questions" (questions which are purposeful and elicit information) throughout the school day.

4. Teach the children to play a simple version of charades. Nursery rhymes, familiar stories or super heroes are good sources for pantomime and questions.

C. To hypotehsize answers to questions

1. Present a tray of objects, such as balls, pieces of paper, crackers, chalk, containers of water, lollipops, etc. Have the child choose an object. Ask the child what will happen to the object if she/he drops it. After the child drops the object, ask "What happened? What will happen if you drop the object again?" Allow the child to repeat the activity with other objects.

2. Repeat the above activity using different surfaces. Have the child drop objects on sidewalks, grass, rugs, asphalt, etc. and predict what will happen.

3. Tell the child to find two objects in the room. Ask the child to guess which object is heavier. Provide a balancing scale, so that the child can verify his/her guesses. Then show the child a ball of clay and weigh it. Flatten the clay and ask the child if she/he thinks the clay

will weigh more or less. Weigh it again. Alter the shape of other objects and compare their weights before and after the alteration. For example, compare the weights of a bowl of soapy water before and after you blow bubbles in it with a straw, or compare the weights of a pencil before and after you break it in two.

4. Search with the child for an ant colony outside. When she/he has found a colony, tell him/her to put some cookie crumbs nearby and guess what the ants will do. After the ants have made a trail to the cookie crumbs, ask the child what will happen if she/he blocks the trail with a rock. Then, try it. Ask what will happen when you wash part of the ant trail with detergent. Try it.

5. Fill a container with hot tap water. Have the child feel the temperature of the water. Then ask him/her what will happen when she/he puts an ice cube or snow in the water. "How will the water feel? What will happen to the ice cube? How will the water feel after we add boiling hot water to it?" Repeat the experiment with a large thermometer in the water. "What will happen to the thermometer when you put an ice cube in the water? What will happen to the thermometer when we pour boiling water into the water?"

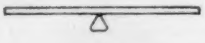
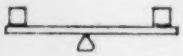
6. Have the child gather leaves in the fall and bring them back to the classroom. Ask lots of questions about the leaves and help the child set up conditions to test his/her hypotheses. "What happens to leaves that are wet/dry? What happens to leaves in the dark/light? Do dry/wet leaves have an odor? What happens to leaves in very cold/hot

temperatures?" Encourage the child to pose his/her own questions.

D. To test out or verify hypotheses

1. Give the child a magnet and let him/her play freely with the magnets for a while. Then ask, "What does the magnet pick up? What doesn't it pick up? Does a magnet attract through other objects? How can you find out? What things does/doesn't a magnet attract through? Does a magnet attract things from far away? How far away?" Have the child ask his/her own questions about the magnets and find out the answers. Provide reference materials about magnets which the child can use.

2. Present the child with some worms, soil for the worms, dark and light paper, a magnifying glass, and a flashlight. After the child has observed the worms in the soil and handled them for a while, pose some questions about the worms. "Do worms like light?" Encourage the child to use the available materials to find out. "What kind of soil do worms like--cold, hot, wet, dry, hard, soft? How can you find out? What do worms do in the winter? When do they eat? How can you tell which is the front and which is the back of the worm? Do worms have feet?" Encourage the child to pose his/her own questions and provide reference materials about worms.

3. Set up a balancing board by placing a long flat board on a fulcrum piece.  Place a small block on each end of the board until it balances.  Challenge the child to find other ways to

balance the board using one block or three or more blocks. Have the child find other objects which might be used as fulcrums.

4. Show the child several plants. Ask him/her what plants need to stay alive and grow. "How can you find out? What will happen to a plant without sunlight/water? How can you find out? Do plants like heat or very cold temperatures?" Encourage the child to devise his/her own experiments to answer these and his/her own questions. Then help the child record his/her findings.

E. To record observations and findings

Since the child probably cannot read or write, encourage him/her to use charts, pictures and other symbolic means to record information. The following example can be adapted to various situations:

1. Have the child sprout alfalfa seeds by soaking them overnight and then covering them on a tray with a wet towel. Help the child take polaroid photos of the seeds before sprouting them and each day of the sprouting process. Then compare the pictures to see how the sprouts have changed. Use this method to record other changing processes, such as a growing sweet potato vine, mold growing on a piece of bread, leaves growing on a branch in early spring, etc.

2. Provide a flannel board doll with costumes for different weather conditions. Have the child dress the doll for the particular weather conditions of each day. Each day ask the child why she/her dressed the doll as she/he did. You may want to have a doll for each day of the

week, so that the child can observe how the weather has or has not changed that week.

3. Gather objects outdoors with the child such as litter or natural objects. Then tell him/her to choose some way to classify the objects, such as by color, size, shape or aesthetics (ugly and pretty objects). Encourage the child to record the classifications by making a collage, separating the classifications in some way. She/he might encircle each classification with a piece of yarn on the collage.

4. Encourage the child to record classifications of objects using pictures. For example, draw a horizontal line across a poster board. Color the lower half of the board black. Then have the child classify vegetables according to whether they grow above the ground or in the ground and attach pictures of those vegetables "under the ground" or "above the ground" on the poster board. The child might also use this method to record floating and sinking objects.

5. Ask the child to dictate his/her experiments to you. Print the date, ask him/her to describe what she/he did and the materials used. Keep a log of what happens over a period of time.

6. Ask the child to draw pictures of his/her experiments. Print or help him/her print the date on the picture and label (print words) the objects drawn. Collect the pictures until the experiment is completed and, then, make a book of the drawings.

F. To summarize and apply information

When the child uses a particular resource, ask questions which will encourage him/her to summarize the information and use it. For example, if she/he has shown interest in snakes, help the child find an appropriate fact book about snakes. Ask questions, such as, "Where would you look for snakes outdoors? Find some pictures in this book that will help you find out. What would you feed a pet snake?" Then encourage the child to use the information if possible. You might help him/her search for snakes, or have the child find things outdoors that a snake could eat.

G. To communicate information to others

1. Have the child tell a flannel board story about a concept in which she/he shows interest. Provide flannel board props which are related to the topic. If the child has shown interest in plants, you might provide a sun, clouds, a plant, etc. Start the activity by saying to the child, "Tell us a story about plants on the flannel board." Accept the child's story even if it isn't completely factual or accurate. Compliment him/her on the imaginativeness of the story, and if appropriate at that time, give him/her correct information.

2. Have the child test several objects to see if they sink or float. Help the child record the results in some way. When the class is assembled for a group activity, have the child show the others one of the objects and ask them whether they think it will sink or float. By referring to his/her record, the child will be able to tell the others if they have guessed correctly. Then have the child retest the object for the group to verify his/her record. Repeat the activity with the other objects.

ANNOTATED LIST OF RESOURCES

1. Bergman, A. B. Environmental education for early childhood, Science and Children, May 1974, XI (8), 14-15.

This is a report of an eight-day investigation by five-year-olds of local plant life in an urban area. The article offers a day-by-day outline for replicating such an activity and suggests several learning goals. Some of these goals are: 1) to exercise observational skills, 2) to identify a few plants and various parts of the plants, 3) to understand the term "community" as applied to plant life, and 4) to observe the relationships between members of this plant community.

2. George, K. D. Science for the preschool child. Science and Children, September 1968, VI (1), 37-38.

This article describes the skills children need to investigate science problems and how a teacher may encourage the development of those skills. The five skills mentioned are: 1) observing through the senses, 2) comparing objects, 3) classifying groups of objects, 4) communicating information to others, and 5) questioning about the environment. The author warns against dividing science content areas too much and outlines several broad themes for preschool science study: 1) the earth and its environment, 2) material objects on the earth, 3) energy (magnetism, electricity, etc.), 4) living things.

3. Hodgden, L., Koetter, J., Laforse, B., McCord, S. and Schram, D. School before six: A diagnostic approach (Vol. II). St. Louis, Missouri: CEMREL, Inc., 1974.

This science section of this book stresses two goals for an early education science curriculum: 1) to develop a "questioning" attitude, and 2) to acquire the skills and knowledge of how to find answers. The suggested role of the teacher towards these goals is to act as a resource, guide and provider of materials. Several very good activities are suggested covering such topics as measuring plant growth, recording weather conditions, heat and cold, and pulleys.

4. Holt, B. Science with young children. Washington, D. C.: National Association for the Education of Young Children, 1977.

Holt describes the skills young children use in science investigation and the role of the teacher in science learning. The book contains many suggestions for science activities and a lengthy bibliography. There is also a list of poisonous plants.

5. McGavack, J. Jr. and LaSalle, D. P. Guppies, bubbles, and vibrating objects: A creative approach to the teaching of science to very young children. New York: John Day Company, 1969.

Although this book contains science activities for elementary school, many of these activities can be used at the preschool level. The activities are based on the assumption that children need to learn science through discovery, manipulation and asking questions. The book includes an extensive explanation of the merits of the "inquiry" approach to teaching science. There are twenty-one units of investigation including balance, classification, simple chemistry, heat and cold, magnets, measurement and plants. Each unit includes several fascinating activities for firsthand investigation with suggested problems for the teacher to pose.

6. McIntyre, M. Science and Children. Volumes XII (2) through the present.

Ms. McIntyre offers a continuing series of articles on science at the preschool level. The articles explain the applicability of different science concepts at the preschool level. The suggested activities are extremely motivating for preschoolers and easy to carry out.

7. Pilty, A. and Sund, R. Creative teaching of science in the elementary school. Boston, Massachusetts: Allyn and Bacon, 1969.

This book outlines principles of creativity in the classroom as applied to science. It includes research studies on creativity, classroom conditions for creativity in science, and guides for parents to encourage creative science investigation at home. The suggested activities for the classroom are too difficult for most preschoolers.

8. Roche, R. Young children and science. Washington, D. C.: Association for Childhood Education International, 1964.

This pamphlet offers ways to organize an early education science program. The main goals stressed are: 1) to "develop desirable attitudes and behaviors" (curiosity, inquiry, investigation), 2) to gain knowledge in order to interpret the world around oneself, and 3) to bring order to science learning. An extensive sample of appropriate questions demonstrates what to ask children in order to stimulate thinking. The responsibilities of the teacher are explained as assessing changes in behavior and providing appropriate materials.

9. Russell, H. R. Ten-minute field trips: Using the school grounds for environmental studies. Chicago, Illinois: J. G. Ferguson Publishing Company, 1973.

Although this book is geared toward older children (elementary school age), there are many ideas which can be adapted to the preschool level.

The book contains several sections which cover plants, animals, interdependence of living things, physical science, and earth science. Each section contains suggested classroom activities, teacher preparations, and field trips possibilities. All the field trips can be taken on city school lots. The suggested approach is investigation by children and questioning by the teacher to stimulate curiosity.

10. Spodek, B. Teaching in the early years. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

This textbook includes a chapter on "Science in the early Years," which emphasizes science as discovery. It also stresses the importance of teaching the system of scientific inquiry.

11. Yardley, A. Discovering the physical world. New York: Citation Press, 1973.

In this book, Yardley examines the way children develop mathematical and scientific concepts, from birth to elementary school age. The author suggests different experiences which help children learn various concepts and offers ideas for the teacher to facilitate this learning. The book contains chapters on finding out about soil and living things, water, air, light, sound, the human body and the way things work.